1925.

[Reissue, May, 1925.

New Zealand Department of Agriculture.

BULLETIN No. 104.

7 APR. 1926 MYCOLOGY

SILVER-BLIGHT, STEREUM PURPUREUM PERS.,

ITS APPEARANCE, CAUSE, AND PREVENTIVE TREATMENT.

G. H. CUNNINGHAM, Biological Laboratory, Wellington.

SILVER-BLIGHT ("silver-leaf") is common in orchards throughout New Zealand. It occurs also in Australia, Canada, South Africa, and Europe. This disease attacks a large number of different plants, being common in New Zealand on almonds, apples, apricots, cherries, currants, gooseberries, nectarines, peaches, pears, plums, and quinces, as well as on many ornamental shrubs and trees such as laburnum, lilac, poplar, silver-birch, willow, &c. So far as I am aware, it does not infect indigenous plants.

EFFECT ON THE HOST.

Silver-blight attacks the shoots, stems, and roots of woody plants, its presence first becoming noticeable by a silvering of the leaves (Fig. 2). This symptom as a rule first shows on one or two small branches, and extends rapidly until all the branches on a limb become affected; it then spreads to other limbs of the tree until all become infected. Sometimes the leaves silver simultaneously over the whole tree, but this is not a common manifestation of the disease. Shortly after the leaves show the characteristic silvered appearance the branch begins to decline in vigour and shortly dies, either the same season or after one or several seasons, during which it continues to show leaf-silvering. Where infection is confined to a single branch it would appear that the organism has gained entry through some injury on that particular branch. Where infection is general over the whole tree the organism has probably gained entry through the stem. Infection is almost invariably followed by death of the branch or tree attacked, but occasionally trees have been known to recover. These trees are by no means immune, however, and may succumb to subsequent attack. Silver-blight is not spread by the secateurs during pruning operations, numerous experiments having demonstrated this.

ECONOMIC IMPORTANCE.

This disease is general throughout the orchard areas of New Zealand. Although it attacks pip-fruits its effects on these are not as severe as on stone-fruits. In apple orchards it probably causes about 1 per cent. loss, on pears its affects are less marked, but with apricots, peaches, and plums the loss is well over 10 per cent., being even more in the case of plums. It probably causes as great a loss as any other orchard disease, with the possible exception of black-spot, but its severity is not readily noticeable, probably because of its gradual onset. A serious feature of the disease is that it cannot be controlled by spraying.

APPEARANCE IN THE FIELD.

The first indication of infection is a silvering of the leaves. Leaves showing silvering become in colour somewhat ashy, tinged with green, and tend to curl slightly at the edges (Fig. 2.), so that an infected tree is readily discernible at some distance, the light colour of the leaves showing in marked contrast to the normal dark green of healthy leaves.

a *b*

FIG. 1. STEREUM PURPUREUM PERS.

a. On willow-branch. *b*. On trunk of peach-tree (living). Two-thirds natural size

[*Photo by E. B. Levy.*

Shortly after the leaves show silvering, the branch, as previously mentioned, begins to decline in vigour, then the leaves begin to fall prematurely, until the branch becomes bare, when it stands out prominently. Other branches soon begin to show leaf-silvering, and in turn all branches exhibit this condition, until finally the whole tree becomes infected and dies. The death of an infected branch or even of the entire tree may occur within a short period of the first appearance of silvering of the leaves, but more frequently the tree lives for one or two seasons after its initial infection. Following the death of the tree the fructifications of the causal organism appear (Fig. 1), often

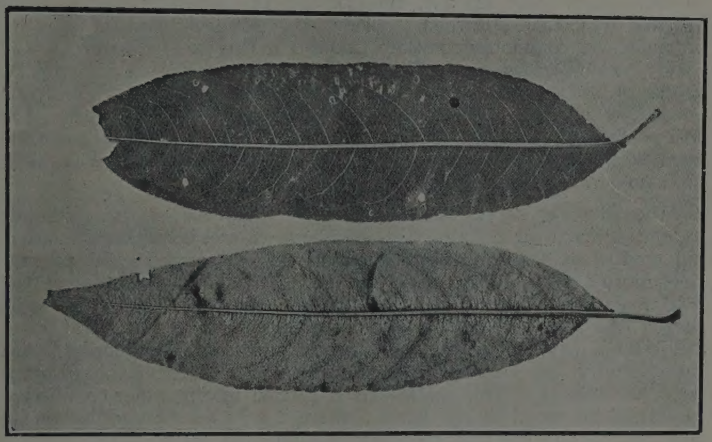


FIG. 2. HEALTHY LEAF AND SILVERED LEAF OF SOLWAY PEACH (UNDER-SURFACE.) TWO-THIRDS NATURAL SIZE.

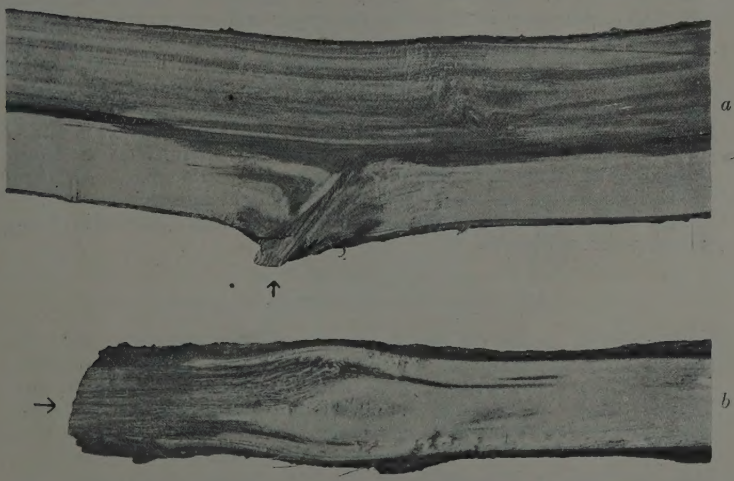


FIG. 3. WOOD INFECTED WITH STEREUM.

(*a*) Branch of willow, showing area discoloured by the fungus; median section through Fig. 1, a; arrow points to place of entry through stub of branch. Two-thirds natural size. (*b*) Shoot of peach which was showing silvering in the leaves; arrow points to place of entry of fungus through unprotected stub of branch. Natural size.

[*Photos by E. B. Lavy.*

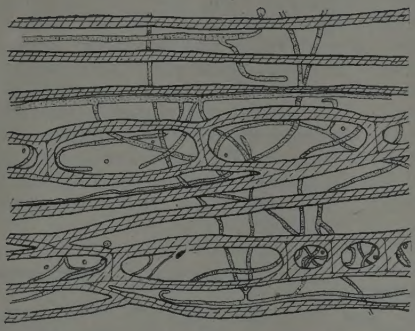
on branches which have died before the whole tree has succumbed. In appearance these are flat, more or less circular disks, having their margins somewhat upturned. They may reach a diameter of 3 in. or more, but commonly they are about 1 in. across. Frequently the upper portion grows away from and at right angles to its support, forming a minute shelf (Fig. 6, a), when the upper surface is seen to be covered with coarse fibres arranged in differently coloured zones. The free surface of the fructification is smooth, and may range in colour from white, through salmon-pink, to purple; usually, however, it is plum-colour. On this surface the spores are borne.

The silvering of the leaves is due to the cells of the epidermis separating from the palisade cells just beneath and becoming somewhat enlarged (Figs. 7 and 8), so that air-cavities are formed which prevent the chloroplasts (bodies containing the green colouring-matter of the leaf) from being clearly seen through the epidermis. The other cells of the leaf also become somewhat disintegrated. The separation of the cells is held to be due to a solvent substance produced by the mycelium of the causal organism, which is situated some distance from the leaves. This substance is carried in the water-conduction vessels of the wood to the leaves, where it acts on the middle lamella (Fig. 5), causing the cells to separate from each other.

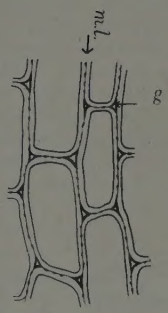
A silver-leaf condition similar to the one under discussion is sometimes noticeable on fruit-trees and ornamental shrubs. For example, a silver-leaf condition common on laurustinus (*Viburnum* spp.) and rhododendron is caused by thrips. To distinguish true silver-blight all that is necessary is to scrape the upper leaf-surface gently with a pocket-knife, when the epidermis will readily peel off, exposing the dark-green cell-contents beneath. When a branch is infected with silver-blight the wood subsequently becomes brown in colour, the discoloration first being noticeable where the organism gained entry through a wound in the surface (Fig. 3). This discoloration is not so pronounced in young shoots, where it appears in the form of brown streaks which diminish in size and number towards the apex. Although wood-discoloration invariably follows silver-blight infection, cases have been recorded where no visible discoloration has been observed in shoots showing silvered leaves.

LIFE-HISTORY OF THE CAUSAL ORGANISM.

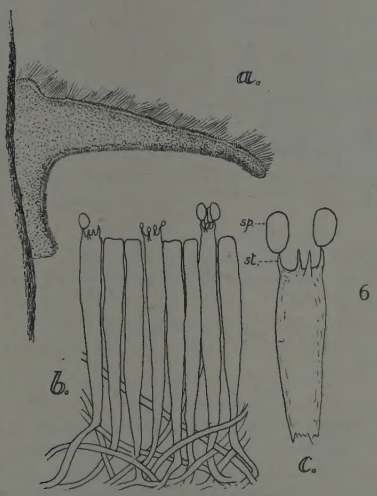
For many years the cause of silver-blight was unknown, this condition being attributed to various agencies, such as unsuitable manures, too heavy pruning, &c., until 1902, when J. Percival suggested that the disease was caused by the fungus *Stereum purpureum* Pers., his reason being that this fungus invariably appeared on trees that had been killed by silver-blight. His suggestion was not generally accepted by mycologists at the time, largely owing to the fact that no traces of the mycelium could be found in the leaves. Subsequent inoculation experiments (in which pieces of the fructifications of *Stereum* were inserted beneath the bark of a tree, and invariably within a short time produced the true silver-blight condition in the leaves and the wood) have proved beyond doubt that *Stereum* is the cause of silver-blight.



4



5



6

Fig. 4. Camera lucida drawing of section of wood of willow taken from zone between discoloured and normal wood shown in Fig. 3, *a*. The hyphæ are crowded in the region of the medullary rays. × 500 diam.

Fig. 5. Camera lucida drawing through parenchyma of apple-shoot, showing middle lamella (*ml*), and gussets or thickened portions (*g*), which were at once time intercellular spaces. × 500 diam.

Fig. 6, a. Section through fructification of *Stereum*, showing hairy upper surface and smooth lower surface; the lower surface is the hymenium, or spore-bearing surface. × 6 diam.

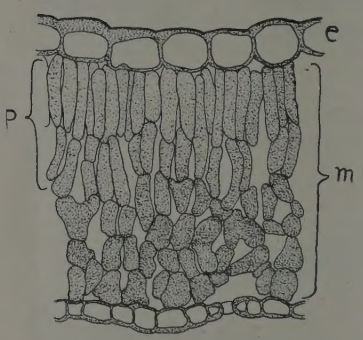
Fig 6, b. Camera lucida drawing of section of hymenium, showing basidia and paraphyses. × 500 diam.

Fig. 6, c. Diagram of basidium, showing sterigmata (*st*), and basidiospores (*sp*). × 1,000 diam.

[*Fig. 6, a by E. H. Atkinson; others by author.*

A typical fructification consists of a flat disk-like or shelf-like receptacle consisting of closely-packed hyphæ so woven together that it assumes quite a leathery appearance. This receptacle is attached to the bark of the tree by numerous hyphæ which penetrate deeply into the wood. The free surface is lined with a coloured layer, the hymenium, which consists of basidia and paraphyses packed closely together (Fig. 6, b). On the apices of the basidia are four small projections (sterigmata) (Fig. 6, c, *st*) on which the spores (basidiospores) (Fig. 6, c, *sp*) are borne. The paraphyses are sterile basidia (Fig. 6, b), their function being unknown. The spores are readily detached, and

7



8

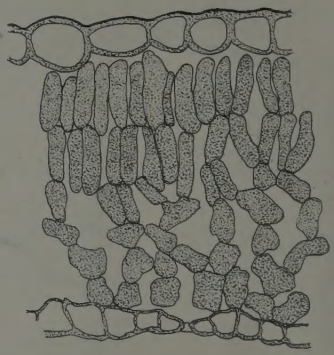


Fig. 7. Camera lucida drawing of section through healthy leaf of peach showing cells containing chlorophyll (stippled), (*m*); palisade cells (*p*); epidermis (*e*). × 350 diam.

Fig. 8. Camera lucida drawing of section of a silvered leaf, showing separation of epidermis from palisade cells, and the disintegration of the mesophyll cells. × 350 diam.

[*Drawings by the writer.*

are carried by wind or other agency to trees growing in the vicinity. Should a spore alight on a wounded surface of a tree it germinates and produces a fine germ-tube (hypha) which penetrates the cells of the wood, where it grows and branches repeatedly, the branches (hyphæ) penetrating into the killed cells.* *Stereum* is a saprophyte, growing on dead stumps, poplar and willow posts, and fallen logs, but should opportunity arise for its hyphæ to penetrate the living tissues through some wounded surface it becomes an active parasite. In living branches the hyphæ confine themselves to the wood, where they grow towards the apex of the branch much more rapidly than towards the root. When all the cells in the vicinity have been killed, and the branch in consequence has died, hyphæ grow out to

* It is probable that from the tips of these hyphæ is secreted a substance which has a solvent action on the cell-walls. This substance kills the cells in advance of the hyphæ, and acts on them in such a manner that they may readily be penetrated by the hyphæ.

the surface, where they branch repeatedly and form the fructifications on which spores are produced, so completing the cycle.

Fructifications, and consequently spores, may be produced at any time of the year. They appear more frequently during wet weather, and favour a moist atmosphere such as surrounds the base of a tree when it is covered by grass or weeds. Spores may be produced at intervals during the life of the fructification, which in many instances persists for several seasons. As previously stated, this fungus can infect living trees only through a wound of some kind. In orchard practice wounds are constantly being inflicted on trees. During cultural operations portions of bark are frequently abraded by chains, swingletrees, or cultural implements. In picking, branches frequently become broken or split at the forks. In pruning, small wounds are made by the secateurs, and large wounds by the use of the saw. Pests such as woolly aphis or cicadas form cankered areas which afford excellent opening for the entry of spores.

PREVENTIVE TREATMENT.

As this fungus is spread by means of spores produced on the fructifications (and by this means alone), and as these spores can gain entry into the tissues of a tree only through a wound or bark injury of some kind, it becomes apparent that by removing the fructifications and coating the wounded surfaces with a protective covering the disease can be kept within reasonable limits, if not combated altogether. The following treatment is recommended :—

Remove and burn all branches and stumps that are showing signs of silver-blight or that have been killed by it. Destroy all dead stumps of shrubs and trees carrying fructifications of *Stereum*. It is not sufficient to cut off the fructifications, as the wood is permeated with the mycelium, which will produce more fructifications as soon as conditions are favourable.

Protect all wounded surfaces over 1 in. in diameter, so that spores cannot enter crevices therein. This first necessitates cutting all broken branches off clean, an operation which should be performed as close to the main branch as possible, so that the wound may quickly callus over. Where a rough surface is left after a saw-cut it should be dressed smooth with a knife. Injuries caused in cultural operations should be dressed smooth, and all loose pieces of bark removed.

Finally, all exposed surfaces should, as soon as made, be dressed with a wound-covering. The cheapest and most efficient wound-dressing to apply is ordinary coal-tar. It is a combined disinfectant (killing all spores present), wood-preservative (protecting the wood against wood-rotting organisms), and protective covering (having the excellent property of pliability, so that it does not crack when the wood expands or contracts), and may readily be applied with a small paint-brush. Wound-dressings should be renewed annually or until such time as the wounds callus over. This is a necessary precaution, as all large wounds have a tendency to crack and expose wood uncovered with any protective coating.

Spraying is useless for controlling silver-blight, as the mycelium is internal and cannot be reached by sprays. Sulphate of iron, which was at one time freely recommended, has also proved to be ineffective for the treatment of this disease. Moreover, all injections into the tree of substances toxic to the fungus have proved fruitless as a controllant.

LITERATURE CITED.

BINTNER, J.—1919, Silver-leaf Disease, *Bull. Miscell. Information*, Kew, pp. 241–263.

BROOKS, F. T.—1912. Silver-leaf Disease, *Jour. Agr. Sci.*, Vol. 4, pp. 133–144; 1913, *ibid.*, Vol. 5, pp. 288–308.

DUKE OF BEDFORD AND PICKERING, S. U.—1910, Silver-leaf Disease, *Woburn Exp. Fruit-farm Rep.* 12, pp. 1–34; 1919, *Science and Fruit-growing*, London, pp. 231–240.

GUSSOW, H. T. —1911, Preliminary Note on Silver-leaf Disease of Fruit-trees, *Phytopath*, Vol. 1, pp. 177–179.

MASSEE, G.—1910, Silver-leaf, *Diseases of Cultivated Plants and Trees*, London, p. 66.

PERCIVAL, J.—1902, Silver-leaf Disease, *Jour. Linn. Soc.*, Vol. 35, pp. 390–395.

[Reprinted from the *New Zealand Journal of Agriculture.*]

THE *NEW ZEALAND JOURNAL OF AGRICULTURE.*

THE *Journal* was established in 1910, as the organ of the Department of Agriculture for the purpose of effectively reaching the rural community with information and advice, and publishing the results of agricultural research and investigation.

The *Journal* contains articles, reports, and notes by departmental experts and others, useful for all engaged in agricultural and pastoral work, dairying, fruitgrowing, poultry-keeping, beekeeping, and gardening, also for those in businesses connected with these industries. The articles are written for New Zealand conditions.

Every man on the land in the Dominion should take the *Journal of Agriculture* as a matter of course. It is produced directly for his benefit.

The *Journal* is published monthly. Subscription 6s. per annum, or £1 for four years, including postage. Subscriptions may be forwarded (preferably by postal note) addressed to the Publisher, Department of Agriculture, P.O. Box 888, Wellington, or handed in at any branch office of the Department.

By Authority: W. A. G. SKINNER, Government Printer, Wellington.—1925.

[2,000/5/25—1756